# Space Weather Technical Forecast

Issued on Wednesday, 02 August 2023 at 13:24 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

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**Space Weather Forecast Headline: M-class flares giving R1-R2 Blackouts expected daily. Glancing blow CME arrivals anticipated Days 3-4 (04-05 Aug) with G1/Minor Storm possible.**

## Analysis of Space Weather Activity over past 24 hours

**Solar Activity:** Moderate solar activity with occasional M-class flares, peaking at M1.3 at 02/0812 UTC from AR3380 in the southwest. There are currently ten active regions on the disc, with AR3380 in the southwest the largest and most complex, although it has weakened, with the delta spot no longer evident. AR3386 persists as a moderately sized region in the northwest disc and has not shown significant changes. AR3392 in the northeast displayed a proliferation of intermediate spots, but is not yet significantly complex. All other regions are small and simple at the present time. Despite this, AR3380 and the unnumbered region in the northeast have both been the source of a number of minor flares over the past 24 hours. No Earth-directed CMEs were observed leaving the Sun on available imagery over the past 24 hours. However, two filament lift-offs from the northeast disc late 31 Jul (and observed on C2 imagery early 01 Aug) are considered to have Earth-directed components.

**Solar Wind / Geomagnetic Activity:** The solar wind at L1, as measured by ACE, was at mostly slow-ambient levels, around or just below 400 km/s. Density was above average but has steadily declined to average levels, with an early period peak of 25ppcc around 01/1400 UTC. The total interplanetary magnetic field strength (Bt) was at weak to moderate levels with a peak of 13nT at 01/1728 UTC. The north-south component was also weak to moderate with a more prolonged southward directed orientation after 02/0400 UTC. Phi angle was initially positive (away from the Sun), becoming positive (towards the Sun) around 01/1600 UTC. Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

**Energetic Particles / Solar Radiation:** GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux varied from background to moderate levels, with a period high levels noted 01/1405-1735 and a diurnal maximum peak of 2010 pfu at 01/1545 UTC. The associated 24-hour integrated fluence remained below the Active level (1e8 integrated pfu), with 3.29e7 integrated pfu recorded at 02/0000UTC.

## Four-Day Space Weather Forecast Summary

**Solar Activity:** Activity is expected to be Moderate, with a slight chance of becoming High. This is mainly due to the potential for M-class flares, along with a chance of X-flares, from AR3380 on the southwest disc. Other regions contribute to the flare risk, including the anticipated return of a notable sunspot region Days 1-2.

**Solar Wind / Geomagnetic Activity:** Two CMEs may give glancing blows on Day 3 (04 Aug), but possibly into Day 4 (05 Aug). Solar winds largely remaining at slow-ambient levels, perhaps

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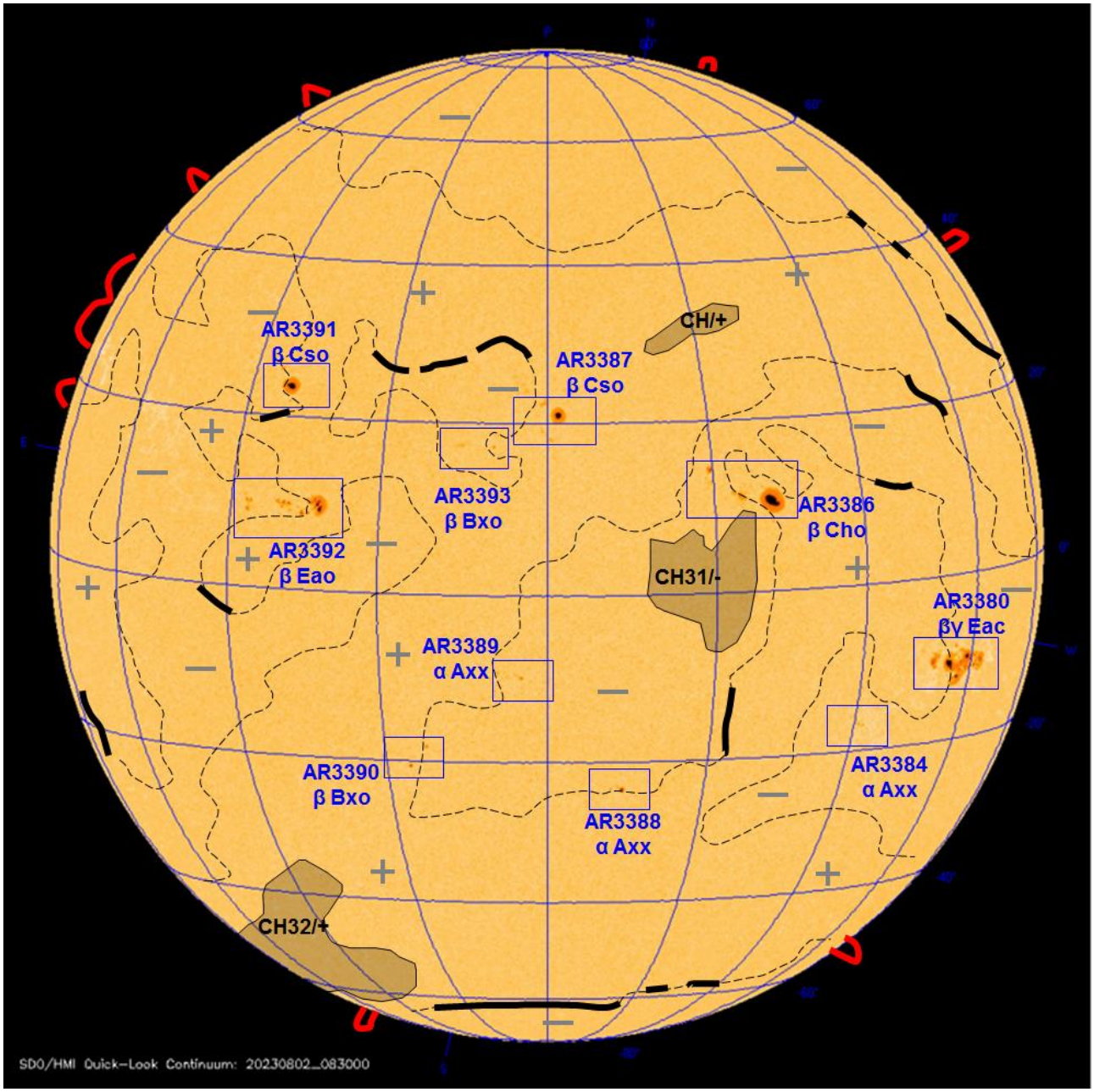
becoming slightly elevated 400-500km/s late Day 3 or more likely Day 4 due to HSS and potential CME influence. Low confidence in details. Geomagnetic activity is expected to be Quiet to Unsettled (Kp0-3), with a chance initially of Active (Kp4) intervals. There is a further chance of Active to G1/Minor Storm intervals late Day 3 into Day 4 with forecast HSS and CME influence.

**Energetic Particles / Solar Radiation:** High energy (greater than 10MeV) proton flux is currently at background levels. There is a slight chance of enhancement from any notable flares that occur, most likely emanating from AR3380. The high energy electron flux (greater than 10 MeV) is expected to have diurnal peaks at High (1000+ pfu) levels Days 1-2, but is likely to drop out due to HSS or CME influence Days 2-4. The associated fluence is most likely to remain below the Active threshold (1e8 total pfu), but with a brief rising trend Day 2 after any recent CME influence subsides, and before impacts from further CMEs are observed.

**Figure 1. Solar Analysis Valid 0800 UTC, 2 August 2023.**

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# Met Office Space Weather Technical Forecast

**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

## Geomagnetic Storms:

A disappearing solar filament occurred in the centre disc from 31/1800 UTC, alongside a C5 flare from AR3380 with a CME, considered to be associated, appearing towards the southwest. In addition, two filament lift offs from the northeast disc produced a CME towards the northeast. Both of these are considered to have an Earth directed component, with arrivals anticipated on Day 3 (04 Aug), but possibly early on Day 4 (05 Aug). Low confidence due to lack of Stereo-A imagery available for analysis. Solar winds are currently exhibiting signs of slight enhancement from a recent CME arrival, at slow-ambient levels, but close to slightly elevated levels. Influence is set to wane through the remainder of Day 1 (02 Aug), with the next enhancement from connection to a high speed stream (HSS) from either CH31/- or an unnumbered CH/+ in the north-centre disc. Both these features are low confidence however, but are coincident with larger and stronger coronal holes on the previous rotation. Any enhancement from these features is expected to be either late Day 2 (03 Aug) or more likely Day 3 which may coincide with potential CME glancing influences to give speeds of 400-500km/s. Geomagnetic activity is expected to be Quiet to Unsettled, with a chance initially of Active intervals. There is a further chance of Active to G1/Minor Storm intervals late Day 3 into Day 4 with forecast HSS and CME influence.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 5 | 5 | 20 | 30 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 01/0701 | Partial | Filament eruption | NE | 599 | 04/0300 UTC | Glancing blow |
| 01/0827 | Partial | Filament eruption | SW | 424 | 04/1400 UTC | Glancing blow |

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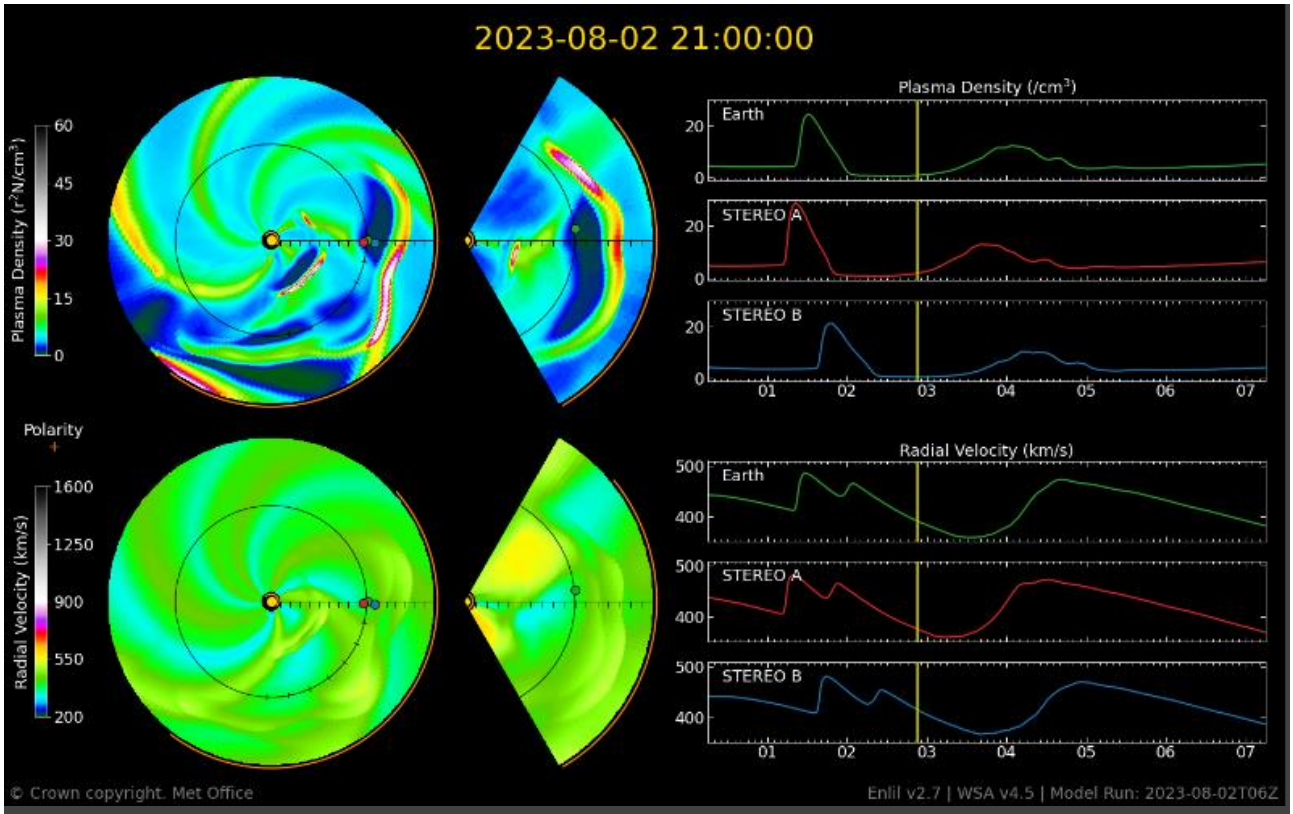
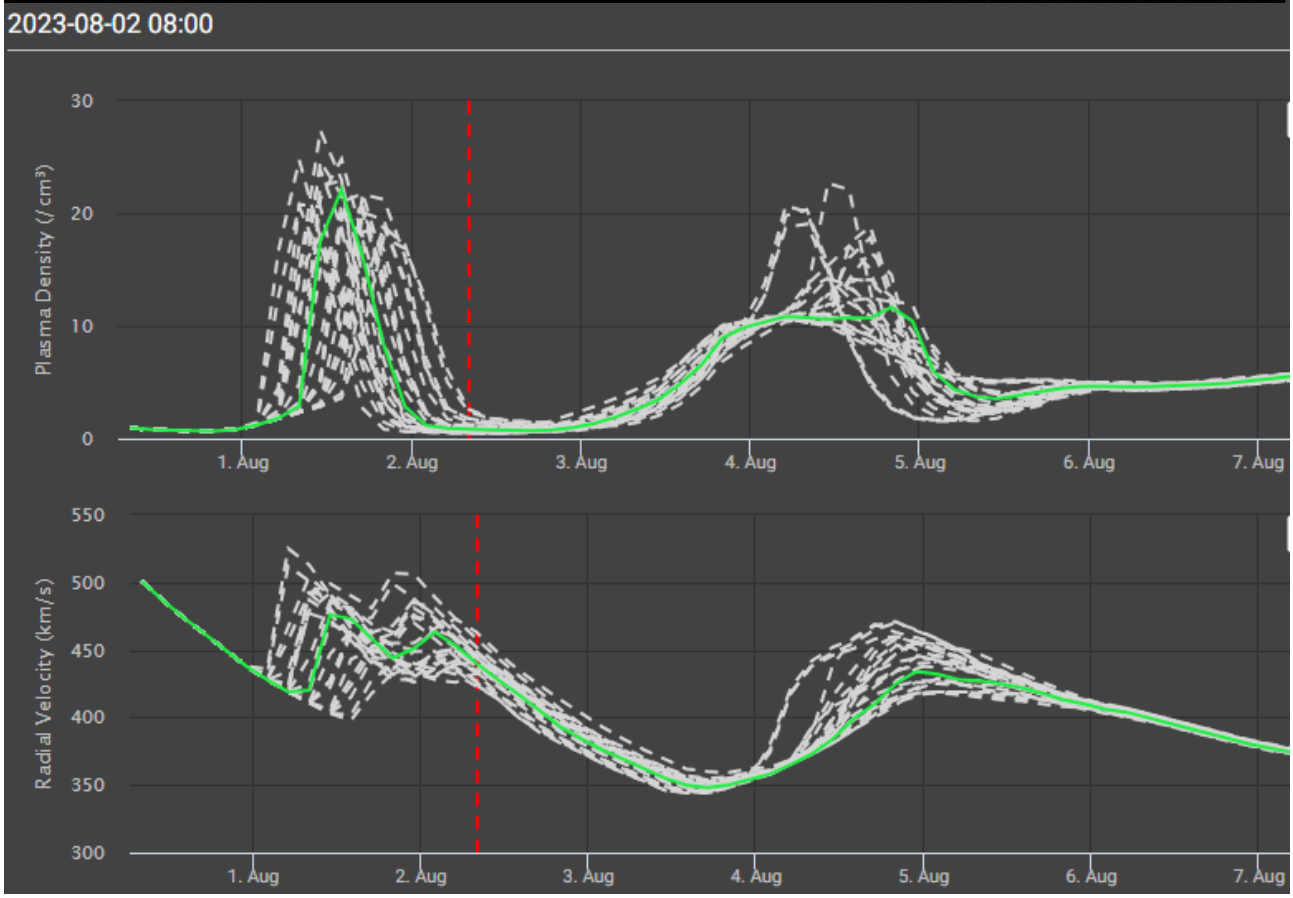
**Figure 2: MOSWOC Enlil and ensemble showing further possible glancing CME blows on 04 August, with some ensemble members showing arrival on 05 August.**

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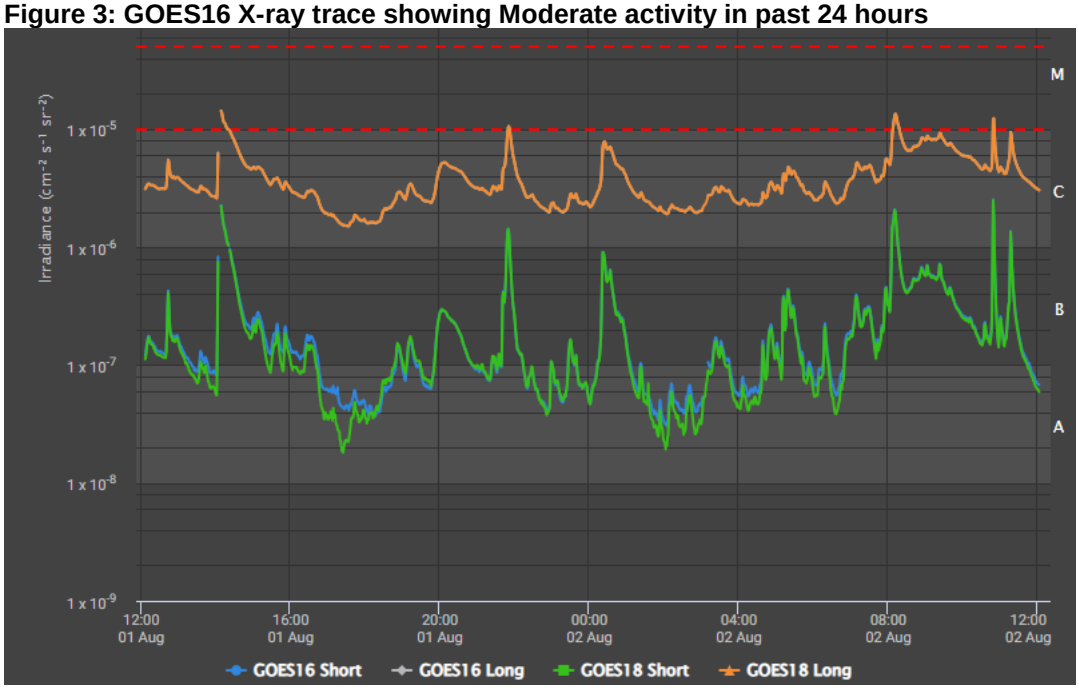
## Radio Blackouts - X-Ray Flares:

Solar activity is Moderate. There are currently ten sunspot regions on the visible disc. The largest and most significant region on the disc remains AR3380 in the southwest. It is still exhibiting magnetic complexity, but is no longer as compact and the delta spot within the region is no longer evident. This region is fairly unstable, and has been the source of a number of M-class flares over the past 24 hours. Stronger flares remain possible, with further M-class flares expected and a slight chance of X-class flares. Of the other regions on the disc, the only ones of note are AR3392 (Eao/Beta) in the northeast and AR3386 (Cho/Beta) in the northwest. The former, a moderately sized region, has shown some proliferation of intermediate spots. AR3386, another moderately sized region has seen ongoing development and fading of a number of intermediate spots and some spreading between the lead and trail portions. The other regions on the disc are comparatively small and simple. However, AR3390 (Bxo/Beta), despite its small size and relatively simple configuration has previously been the source of M-class flares in recent days. Plage visible on the southeastern limb along with looping indicate a potentially large returning region that is due to rotate across the eastern limb during Days 1-2 (02-03 Aug). This probably the return of notable region ex-AR3363, and corresponds to a strong signal in far-side products. However there is low confidence for how much activity this region retains from its far-side transit.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | Yes | 50 | 50 | 70 | 60 |
| Very Active | R3 to R5 X Class | No | 10 | 10 | 15 | 10 |

**Figure 3: GOES16 X-ray trace showing Moderate activity in past 24 hours**

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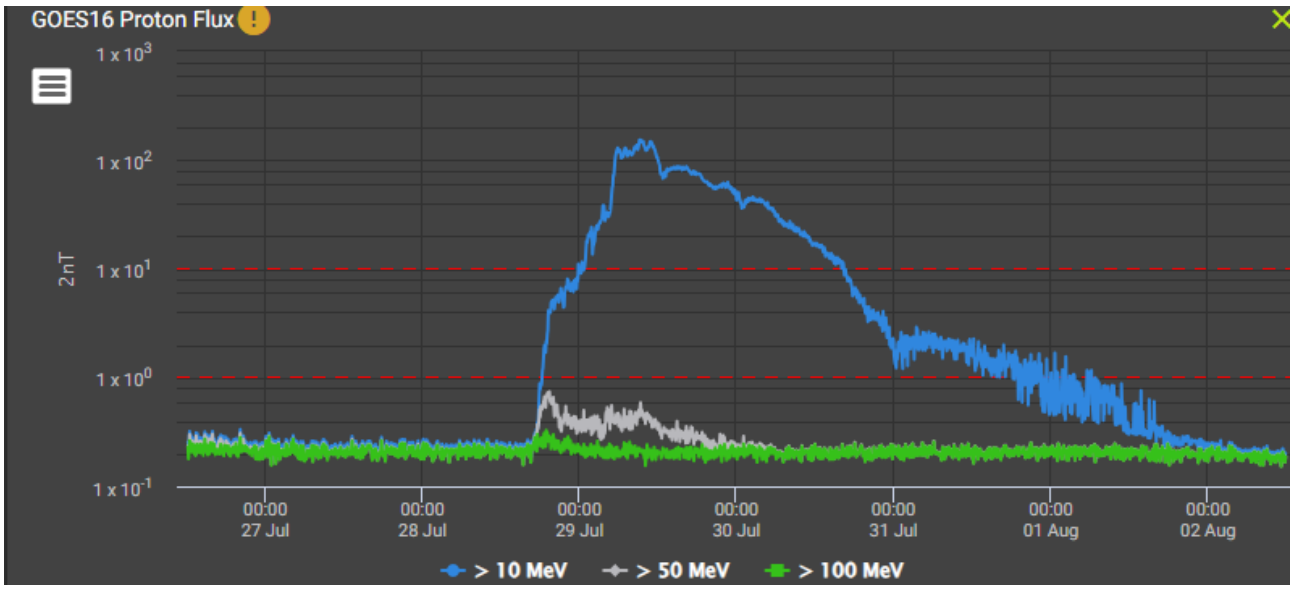
**Solar Radiation Storms - (High Energy Protons):**
The high energy (greater than 10MeV) proton flux is now back to background levels having recovered from the 28 Jul far-sided eruption that brought an S2 Moderate Storm on 29 Jul. No significant enhancement to flux levels was observed following the CME arrival on 01 Aug. The main risk of further proton storms through the period is from the complex region AR3380 in the southwest disc. Any significant flares from this region will bring a chance of further increases in proton flux, with a slight chance of exceeding S1/Minor Storm threshold.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Active | ≥ S1 | No | 5 | 10 | 10 | 15 |
| Very Active | ≥ S3 * | No | 1 | 1 | 1 | 1 |

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

**Figure 4: GOES16 Proton Flux over past seven days. Showing recent decline to background levels.**

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**High Energy Electrons Event (≥ 2MeV):**

High energy (greater than 2 MeV) electron flux observed by GOES-16 is currently at background to moderate levels but is expected to show diurnal variation to peak at High levels during the guidance period. A drop out to background levels of observed flux is likely to occur during either the transition into a speed of coronal hole fast winds either late Day 2 or Day 3 (03-04 Aug) or in association with potential glancing blows from CMEs late Day 3 (04 Aug) or early Day 4 (05 Aug).

The associated 24 hour fluence is forecast to remain below Active (1e8 total pfu) but with a slight chance of rising above, mainly on Day 2 (03 Aug) after recent CME enhancement, and before subsequent coronal hole and potential further CME influence. The Met Office REFM output is currently giving a reasonable steer for initial conditions, but confidence in the model falls low as the period advances.

| GEO Electron Environment | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Active | ≥ 2 MeV ≥ $1x10^8$ | No | 5 | 20 | 20 | 5 |
| Very Active | ≥ 2 MeV ≥ $1x10^9$ | No | 1 | 1 | 1 | 1 |

**Figure 5: High energy electron flux at GEO and MOSWOC REFM showing a generally below Active trend.**

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